Total Maximum Daily Loads: Stevens Creek and Markham Creek Rock County, Wisconsin

Markham Creek, Rock County, WI

WISCONSIN
DEPT. OF NATURAL RESOURCES

INTRODUCTION

Stevens Creek and Markham Creek are two warm water streams located in Rock County of south central Wisconsin. Stevens Creek is a tributary to Bass Creek, which flows into the lower Rock River. Markham Creek is a tributary to the lower Rock River. The Wisconsin Department of Natural Resources (WDNR) placed the entire lengths of Stevens Creek and Markham Creek on the state of Wisconsin's 2004 303(d) impaired waters list as medium priority as impaired due to degraded habitat caused by excessive sedimentation. The Clean Water Act and US EPA regulations require that each state develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list. The purpose of these TMDLs is to identify load allocations and management actions that will help restore the biological integrity of the stream. These TMDLs address each stream individually but are grouped together because both are located in the Lower Rock River Basin, share the same watershed characteristics, soils, and types of land use.

Table 1. Stevens Creek and Markham Creek use designations

Waterbody Name	WBIC	TMDL ID	Impaired Stream Miles	Existing Use	Potential Use	Codified Use
Stevens Creek	796300	469	0-8.35	WWFF	Cold III	WWSF
Markham Creek	796400	267	0-7.31	WWFF	WWSF	WWSF

PROBLEM STATEMENT

Due to excessive sedimentation, Stevens Creek and Markham Creek are not currently meeting applicable narrative water quality criterion as defined in NR 102.04 (1); Wisconsin Administrative Code:

> "To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal; industrial, commercial, domestic, agricultural, land development, or other activities shall be controlled so that all waters including mixing zone and effluent channels meet the following conditions at all times and under all flow conditions:
>
> a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state"

Excessive sedimentation is considered an objectionable deposit.

Additionally, Stevens Creek and Markham Creek are not supporting their codified uses. The existing use for both Stevens and Markham Creeks is a warm water forage fish community (WWFF). The codified uses applicable to this stream are as follows:

S. NR 102.04 (3) intro, (a), (b), and (c), Wisconsin Administrative Code:

"FISH AND OTHER AQUATIC LIFE USES. The department shall classify all surface waters into one of the fish and other aquatic life subcategories described in this subsection. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972, P.L. 92-500; 33 USC 1251 et. seq.

a) Cold water communities. This subcategory includes surface waters capable of supporting a community of cold water fish and aquatic life, or serving as a spawning area for cold water fish species. This subcategory includes, but is not restricted to, surface waters identified as trout waters by the Department of Natural Resources (Wisconsin Trout Streams, publication 6-6300 (80)).

b) Warm water sport fish communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.

c) Warm water forage fish communities. This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life."

The goal of these TMDLs is to reduce TSS loads, to meet narrative water quality criterion, and to improve macroinvertebrate and fish communities in Stevens Creek and Markham Creek. Currently, WDNR has no numeric criteria for total suspended solids (TSS). TSS concentrations are used as a measurable indicator of the stress on the biota of the stream. A water quality load duration curve approach was used to calculate loads for these TMDLs. Concentration targets were chosen for each stream based on a review of existing conditions and published literature on the effects of TSS on habitat and aquatic life. The daily target concentration for Stevens Creek is 50 mg/l and for Markham Creek is 25 mg/l. These targets aim at reducing the sediment load and TSS concentrations approximately 50% during high flow/wet-weather events in both of the streams.

STEVENS CREEK

Stevens Creek is an eight-mile stream in west central Rock County that flows southeast before reaching Bass Creek near Hanover, Wisconsin. It has a gradient of 14.5 feet per mile and a drainage area of 16 square miles. Stevens Creek is listed as having the potential to support a coldwater fish community for its entire length, but is currently supporting a warm water forage fishery. Land use in the watershed is dominated by agriculture, particularly cash grain and pasturing. Land cover for the watershed is outlined in Table 2.

The Lower Rock River Water Quality Management Plan of 2001 noted that the water quality of Stevens Creek is affected by cropland erosion, barnyard runoff, and streambank erosion.

Habitat surveys dating back to 1996 have been conducted to better characterize substrate and in-stream habitat. A May 1996 habitat evaluation characterized the stream's habitat at Mineral Point Road as "poor". Twenty cattle were observed standing in the stream. At this time, the stream's habitat at the Snyder Road crossing was "poor".

Table 2. Stevens Creek land use, WISCLAND

Land Use in Stevens Creek Watershed	Percent Cover
Agriculture	62.0
Grass/Pasture	37.1
Forest	0.8
Water	0.1
Low Density Residential	0.03

WDNR staff conducted habitat surveys in August of 2004 using the current habitat assessment tool for wadeable streams for two locations on Stevens Creek. Both locations indicated "fair" substrate conditions. WDNR rapid habitat assessments (Joe Ball Habitat Assessments) at 4 locations in Steven's Creek indicated similar conditions; with 3 out of the 4 areas having "fair" conditions and one was considered "poor."

Additional biological data collected includes fish surveys and macroinvertebrate surveys conducted between 1996 and 2004. Water chemistry data were collected by WNDR between the years 2004 and 2005. Parameters measured include total suspended solids (TSS), total phosphorus, total dissolved phosphorus, total kjeldahl nitrogen, ammonia, temperature, dissolved oxygen, pH, and specific conductivity. Continuous daily stream flow was measured between 2004 and 2005 in cooperation with the United States Geological Survey (USGS).

MARKHAM CREEK

Markham Creek is a five-mile stream located in west central Rock County that flows southeast before reaching the Lower Rock River near Janesville, Wisconsin. It has a moderate gradient of 15.3 feet per mile and drains an area of approximately eight square miles. Markham Creek is designated as having the potential to support a warm water sport fishery for its entire length, but is currently supporting a warm water forage fishery. Land cover for the watershed is outlined in Table 3.

Table 3. Markham Creek land use, WISCLAND

Land Use in Markham Creek Watershed	Percent Cover
Agriculture	68
Grass/Pasture	30
Forest	1.4
Water	0.2
Commercial	0.1
Low Density Residential	0.1

Land use in the watershed is dominated by two primary agricultural practices: row cropping and grass pasture. In many cases, these agricultural practices occur adjacent to the stream banks, causing immediate runoff to the

stream. This is especially evident during high precipitation or snowmelt events. In upcoming years more residential land use is expected as recent development from the city of Janesville is expanding into the south east corner of the watershed.

WDNR staff conducted habitat surveys in August of 2004 using the current habitat assessment tool for wadeable streams for two locations on Markham Creek. At the Highway D location substrate was considered "fair." O'Leary Road stream habitat had extensive (>60%) fines in pools, riffles, and runs. This is considered "poor" according to WDNR habitat rating guidelines. WDNR rapid habitat assessments (Joe Ball Habitat Assessment) at 3 locations in Markham Creek indicated similar conditions, with 2 of the areas displaying "fair" conditions and one "poor."

Fish and macroinvertebrate data were collected between the years of 1992-2004. Water chemistry data were collected by WNDR during 2004 and 2005. Parameters measured include total suspended solids (TSS), total phosphorus, total dissolved phosphorus, total kjeldahl nitrogen, ammonia, temperature, dissolved oxygen, pH, and specific conductivity. Continuous daily stream flow was measured between 2004 and 2005 in cooperation with the United States Geological Survey (USGS).

SOURCE ASSESSMENT

Point Sources

There are no point source discharges to either Stevens Creek or Markham Creek.

Nonpoint Sources

Sedimentation from agricultural runoff and snowmelt events is the suspected cause of degraded habitat in Stevens Creek and Markham Creek. To investigate potential sources of the pollutant for the TMDL, a TSS load duration curve was developed for Markham and Stevens Creek based on methods outlined by Cleland (2002). To calculate the flow duration curves, continuous daily stream flow from USGS gage stations located at one point on each stream was used (Stevens Creek at Hanover Road and Markham Creek at O'Leary Road). Monthly TSS data were collected by WDNR staff between 2004 and 2005 to calculate the water quality duration curves for the stream (See Appendix B for Load Duration Curves). Water quality duration curves can help target load allocations under different flow regimes. Load duration curves for Stevens Creek and Markham Creek indicate high TSS values only under high flow and moist conditions in the watershed. Exceedances of target values often occur in high/event flow conditions and are most common with nonpoint source pollutants.

LINKAGE ANALYSIS

Establishing the link between watershed characteristics and resulting water quality is a crucial step in TMDL development. By striving to return watershed characteristics closer to natural conditions, improvements in overall stream health can be achieved. However, determining natural conditions of the stream is challenging due to a lack of historical data to represent conditions prior to human disturbance. For example, in many sections of Markham Creek, stream habitat has been affected by channelization that likely occurred during the 1960's and 1970's as part of agricultural actions due to soil conditions. These areas were modified to improve conditions for planting and to increase access to land. Channelization adversely affects streams by altering physical stream habitat, rates of sediment erosion, transport, and deposition.

Sedimentation from stream bank erosion and runoff from agricultural practices within the watersheds are the suspected cause of habitat degradation in Stevens Creek and Markham Creek. Fine sediments covering the stream substrate reduce suitable habitat for fish and other biological communities by filling in pools and reducing available cover for juvenile and adult fish. Sedimentation of riffle areas compromises reproductive success of fish communities by covering gravel substrate necessary for spawning conditions. The filling in of riffle areas also affects the fish communities' food source, macroinvertebrates, which have difficulty thriving in areas with predominantly sand substrate as opposed to a substrate composed of gravel, cobble/rubble, and sand mixture. In addition, sedimentation can increase turbidity in the water column, causing reduced light penetration necessary for photosynthesis in aquatic plants, and reduced feeding capacity of aquatic macroinvertebrates due to clogged gill surfaces. Sedimentation of the substrate can also cause an increase in other contaminant levels, which are attached to sediment particles and transported into the stream during runoff events.

Biotic integrity scores for fish and macroinvertebrate communities are expected to increase as measures are taken to reduce sedimentation and embeddedness of the substrate in Stevens Creek and Markham Creek.

TMDL DEVELOPMENT

A TMDL is a plan to reduce the amount of specific pollutants reaching an impaired waterbody to the extent that water quality standards will be met. As part of a TMDL, the amount of pollutant that the water can tolerate and still meet water quality standards must be identified. Stevens Creek and Markham Creek have been impaired by a combination of flashy flow conditions during runoff events, bank erosion, runoff from agricultural practices, and excessive sedimentation of the stream substrate. The goal of this TMDL is to reduce sediment loads throughout the Stevens Creek and Markham Creek watersheds

to a level that narrative water quality standards will be met and the streams' biological communities will be restored to their listed potential.

In addition to identification of pollutant loading, a TMDL also identifies critical environmental conditions used when defining allowable pollutant levels. A critical condition is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other important conditions. Although sediment is considered a "conservative" pollutant and does not degrade over time or during different critical periods of the year, we define the critical condition for TSS in these TMDLs as occurring after heavy rainfall events (> 0.5 inches) and runoff events (i.e. snowmelts) when flows are high (approximately >5 cfs for Markham Creek, >20 cfs for Stevens Creek based on the flow duration curves for these creeks). At high flow rates the sediment is moved into the streams from agricultural activities and erosion in the watershed. In addition, the existing sediment in the streams can be disturbed and transported downstream. Additionally, high flows in the stream channel may erode the stream bank adding sediment to the stream. Under normal flow conditions TSS levels average 10 mg/l or less, below the TMDL targets of 25 mg/l and 50 mg/l for Markham and Stevens Creeks, respectively.

ALLOCATIONS

The total annual loading capacity for sediment is the sum of the wasteload allocations for permitted sources, the load allocations for non-point sources, and the margin of safety, as generally expressed in the following equation:

$$\text{TMDL Load Capacity} = \text{WLA} + \text{LA} + \text{MOS}$$

WLA = Wasteload Allocation = 0 tons/year (no point sources)
LA = Load Allocation
MOS = Margin of Safety

WLA

Because there are no point sources in the watershed, the wasteload allocation is zero. If a point discharge were proposed, one of the following would need to occur:

- An effluent limit of zero TSS would be included in the WPDES permit
- An offset would need to be created through some means, such as pollutant trading
- A re-allocation of sediment load would need to be developed and approved by EPA

LA

The load allocation (LA) component defines the load capacity for a pollutant that is related to nonpoint source pollution. To achieve the LA, TSS load reductions are necessary in the agriculture land-use areas of these watersheds. The percent reduction (50%) in the LA is based on a reduction of wet-weather runoff event TSS loads with a goal of the daily target stream concentration of 50 mg/l for Stevens Creek and 25 mg/l for Markham Creek. It is important to note that these values target wet-weather events that occur in less than 10% over the flow regime. For 90% of the time, TSS concentrations are typically less than 10 mg/l for Markham Creek and Stevens Creek. See Tables 4 and 5 below for the Load allocations for Stevens Creek and Markham Creek as determined by the Load Duration Curves in Appendix B.

MOS

The margin of safety (MOS) accounts for the uncertainty about the relationship between the sediment loads and the response in the waterbody. For the Stevens Creek and Markham Creek TMDLs, an explicit MOS is provided for each of the flow periods. In these TMDLs, the MOS was calculated based on the difference between the loading capacity as calculated at the mid-point of each of the five flow zones and the loading capacity calculated at the minimum flow in each zone. The MOS assures that load allocations will not exceed the load associated with the minimum flow in each zone. See Tables 4 and 5 below for the MOS for Stevens Creek and Markham Creek.

LOADING CAPACITY

The loading capacity was captured for these TMDLs using water quality duration curves (See Appendix B for Load Duration Curves). For Stevens Creek and Markham Creek, it is evident that sediment concentrations are highest during event flows as a result as runoff from nearby agricultural fields and factors such as channel scour moving the sediment downstream.

For Stevens Creek and Markham Creek the flow duration curves are based on daily average stream discharge data. The flow duration interval of 10 for Markham Creek is associated with a stream discharge of 4 cfs (i.e. ten percent of all observed stream discharge values equal or exceed 4 cfs), as well as a flow duration interval of 90 associated with a stream discharge of 0.56 cfs (i.e. ninety percent of all observed values exceed 0.56 cfs).

The flow duration interval of 10 for Stevens Creek is associated with a stream discharge of 16 cfs (i.e. ten percent of all observed stream discharge values equal or exceed 16 cfs), as well as a flow duration interval of 90 associated with a stream discharge of 2.1 cfs (i.e. ninety percent of all observed values exceed 2.1 cfs). These points can be used to illustrate the calculation of the loading capacity associated with individual duration curve intervals. The loading capacity

and TMDLs for Stevens Creek and Markham Creek are listed in the Tables below.

Table 4. Stevens Creek TMDL Summary					
	Duration Curve Zone				
	(expressed as tons/day)				
	High	**Moist**	**Mid**	**Dry**	**Low**
TMDL	3.24	0.98	0.63	0.49	0.23
MOS	1.08	0.28	0.07	0.20	0.05
LA	2.16	0.70	0.57	0.28	0.18
WLA	0.00	0.00	0.00	0.00	0.00
	Percentage of total daily loading capacity				
TMDL	100%	100%	100%	100%	100%
MOS	33%	28%	11%	42%	24%
LA	67%	72%	89%	58%	76%
WLA	0%	0%	0%	0%	0%

Table 5. Markham Creek TMDL Summary					
	Duration Curve Zone				
	(expressed as tons/day)				
	High	**Moist**	**Mid**	**Dry**	**Low**
TMDL	0.42	0.19	0.11	0.08	0.04
MOS	0.16	0.06	0.01	0.04	0.01
LA	0.26	0.13	0.10	0.04	0.03
WLA	0.00	0.00	0.00	0.00	0.00
	Percentage of total daily loading capacity				
TMDL	100%	100%	100%	100%	100%
MOS	38%	32%	6%	48%	18%
LA	62%	68%	94%	53%	82%
WLA	0%	0%	0%	0%	0%

SEASONALITY

Although sediment as a pollutant reaches Stevens and Markham Creeks under high flow events such as storms and runoff, there is no seasonal variation in the sedimentation of this stream. Under some flow regimes, sediment is deposited, and at other time, sediment is scoured and transported downstream. Sediment can considered a “conservative” pollutant and does not degrade over time. Sedimentation (the deposition of sediment) is a year round situation in which the depth of sediment on the stream bed varies under response of flood flows in the stream. Much of the sediment in this system remains within the confines of the

stream until major floods scour some of the accumulated sediment. Over time, the net result has been an accumulation of sediments in and along the stream under the current amounts of sediment reaching the stream.

The best management practices to achieve the load allocation in Stevens Creek and Markham Creek, such as riparian buffers and conservation tillage are selected and designed to function for 10-year or 25-year, 24-hour design storms, providing substantial control for major rainfall events.

MONITORING

The WDNR intends to monitor Stevens Creek and Markham Creek based on the rate of implementation of the TMDLs. Monitoring for Total Suspended Solids will continue until it is deemed that the streams have responded to the point where they are meeting their potential uses or until funding for these studies are discontinued. In addition, the streams will be monitored on a five-to six-year interval as part of a baseline monitoring strategy to assess temporary conditions and note trends in overall stream quality. The monitoring will consist of metrics contained in WDNR's baseline protocol for wadeable streams, such as the Index of Biotic Integrity (IBI), the Hilsenhoff Biotic Index (HBI), the current habitat assessment tool, and sampling of water quality parameters at a subset of sites.

REASONABLE ASSURANCE

No new or additional enforcement authorities are provided under these TMDLs. There are currently no point source discharges located on either Stevens Creek or Markham Creek. However, future enforcement of non-point source performance standards and prohibitions will likely take place in the watersheds. It is also anticipated that regulatory agricultural and non-agricultural performance standards called for in Wisconsin Statutes will be implemented in the watersheds of impaired waters. Currently, enforcement is based on the opportunity to provide cost-share dollars. If money is offered to landowners violating performance standards, they are obligated to comply. Administrative rules passed by the Natural Resources Board identify that watersheds with impaired waters will have the highest priority for enforcement.

The load duration curves for the Stevens Creek and Markham Creek TMDLs indicate that TSS concentrations are highest in the stream during high flow events. To reach the TMDLs in these watersheds best management practices such as riparian buffers and conservation tillage are encouraged in agricultural land use settings to reduce loading during these events. In addition to the implementation of enforceable non-point source performance standards, there are a number of voluntary programs that will assist in implementing these TMDLs.

Farmers may enroll in the Conservation Reserve Enhancement Program (CREP) or similar programs to establish vegetated buffers on cropland and marginal pastures. Riparian buffers assist in making CREP a viable program for this impaired stream. A similar program available is the Conservation Reserve Program (CRP), which takes highly erodible land out of agricultural use. As of May 2005, 394 acres in the Markham Creek and Stevens Creek watersheds were enrolled in CRP and CREP. Of the 394 enrolled acres, 118 acres are within 20 feet of a stream or major drainage way. Of these, 82 acres are filter strips and the other 36 acres are enrolled as wetland restorations or scrape ponds for wildlife.

The Environmental Quality Incentive Program (EQIP) is another option available to landowners. EQIP is a federal cost-share program administered by the Natural Resources Conservation Service (NRCS) that provides farmers with technical and financial assistance. Farmers may receive up to seventy five percent reimbursement for installing and implementing runoff management practices. Eligible projects can include: terraces, waterways, diversions, and contour strips to manage agricultural waste, promote stream buffers, and control erosion on agricultural lands.

The Rock County LCD may also apply for a Targeted Runoff Management (TRM) grant through WDNR. TRM grants are competitive financial awards to support small-scale, short term projects (24 months) completed by governmental units to reduce runoff pollution. Both urban and agricultural projects can be funded through a TRM grant; however, the grants require a local contribution to the project. The state share is capped at $150,000.

PUBLIC PARTICIPATION

This section will be completed after review of the draft.

This TMDL was subject for review from July 25, 2006 through August 25, 2006. On July 25, 2006, a news release was sent to: newspapers, television stations, radio stations, interest groups, and interested individuals. The news release indicated the public comment period and how to obtain copies of the public notice and the draft TMDL. The news release, public notice, and draft TMDL were also placed on the WDNR's website. In addition, hard copies were sent to _____. _____ comments were received.

REFERENCES

Cleland, Bruce, 2003, TMDL Development from the "Bottom-Up"-Part III: Duration Curves and Wet-Weather Assessments.

Cleland, Bruce, 2002, TMDL Development from the "Bottom-UP"-Part II: Using Duration Curves to Connect the Pieces.

WDNR, 2001, Lower Rock River Water Quality Management Plan-Bass Creek Watershed (LR03).

WDNR, 1970, Surface Waters of Rock County.

USEPA, 2006, Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria

USEPA, 1999, Protocol for Developing Sediment TMDLs.

APPENDIX A: MAPS & FIGURES

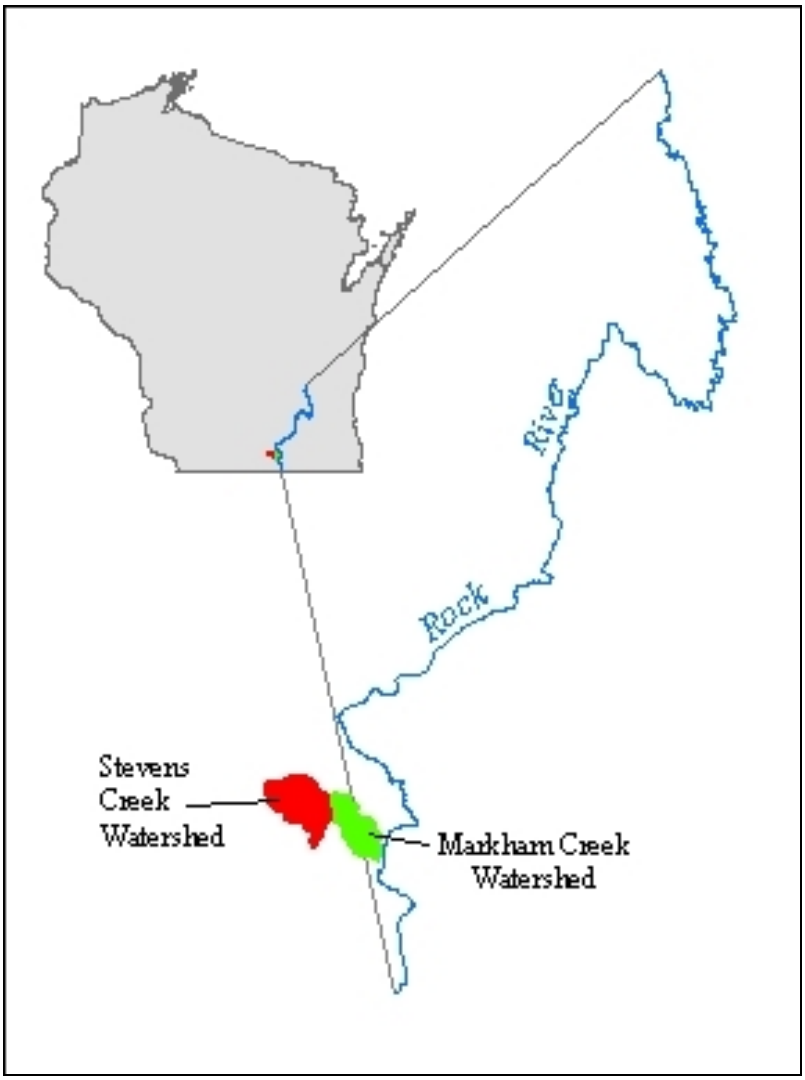


Figure 1. Stevens Creek and Markham Creek Watersheds' Locations in Wisconsin

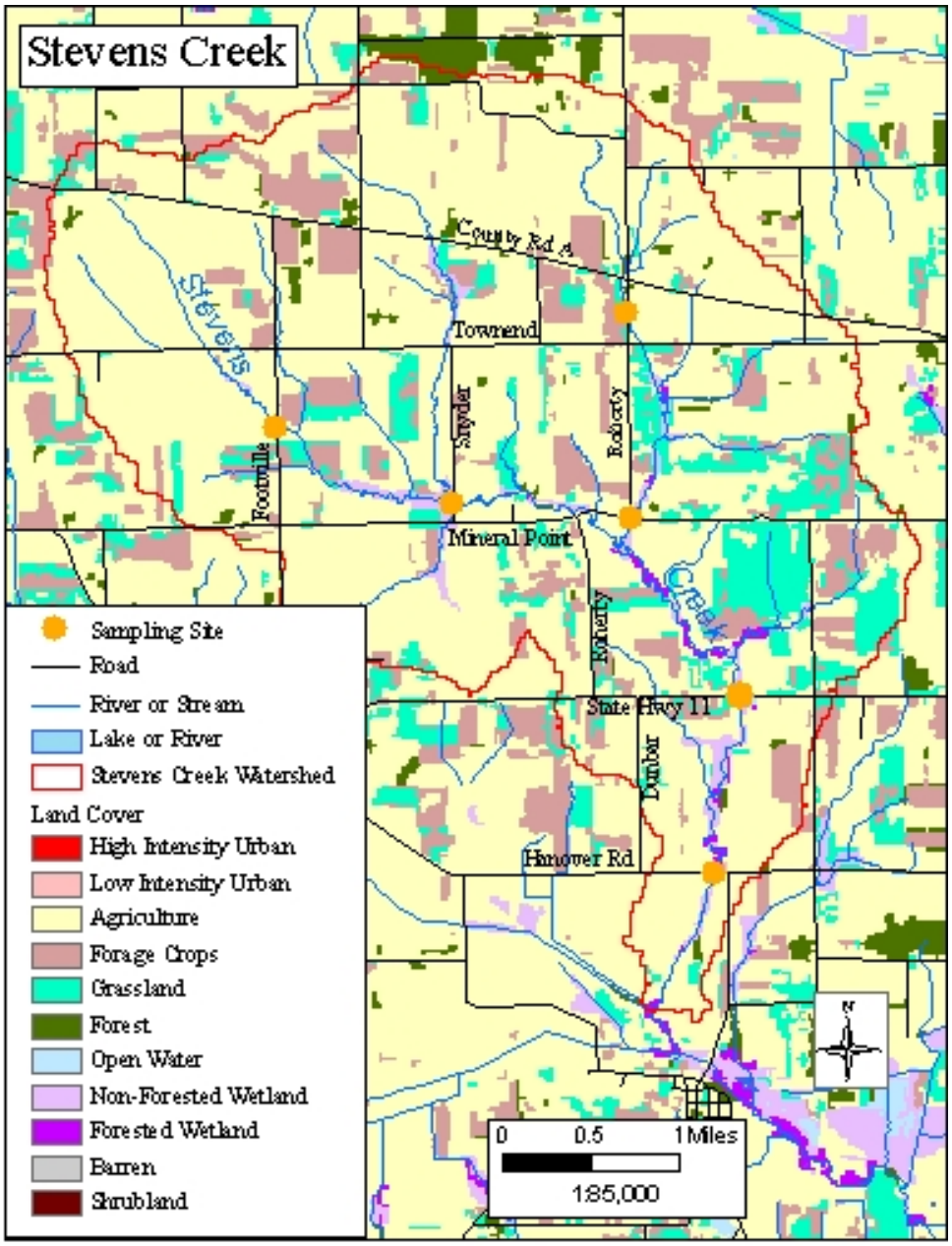


Figure 2. Stevens Creek Watershed Land Use and Sampling Locations for TMDL Development

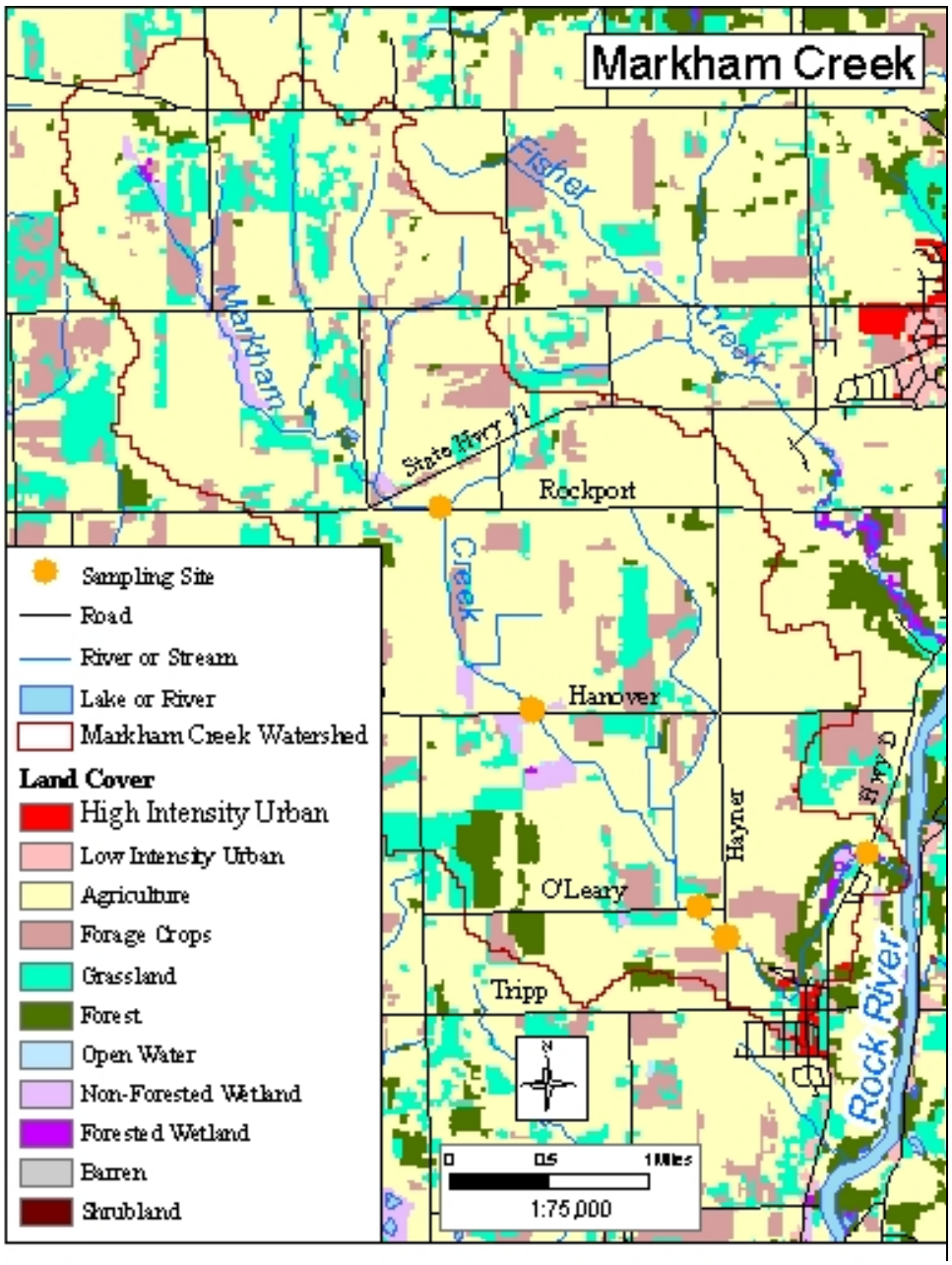
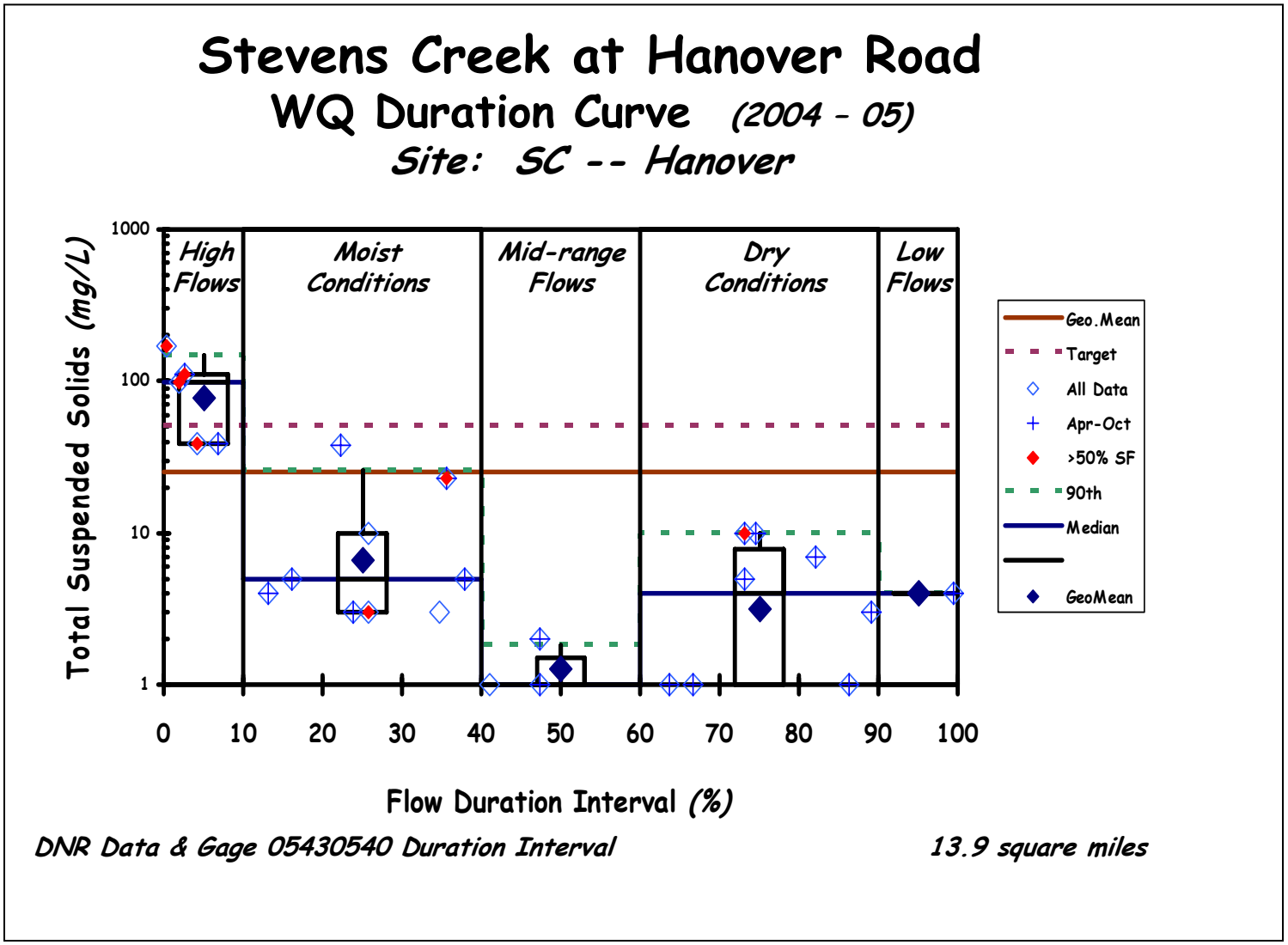
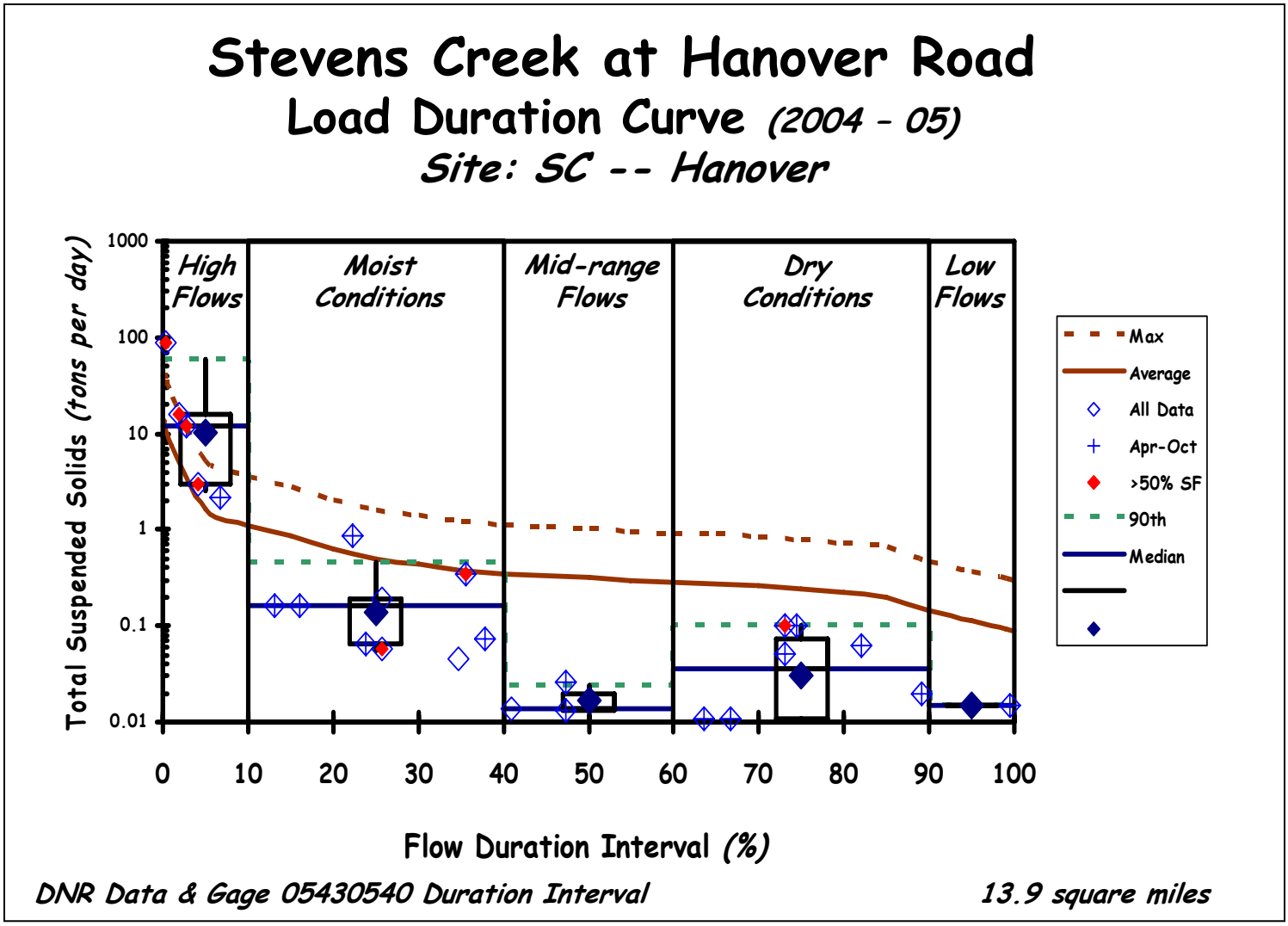


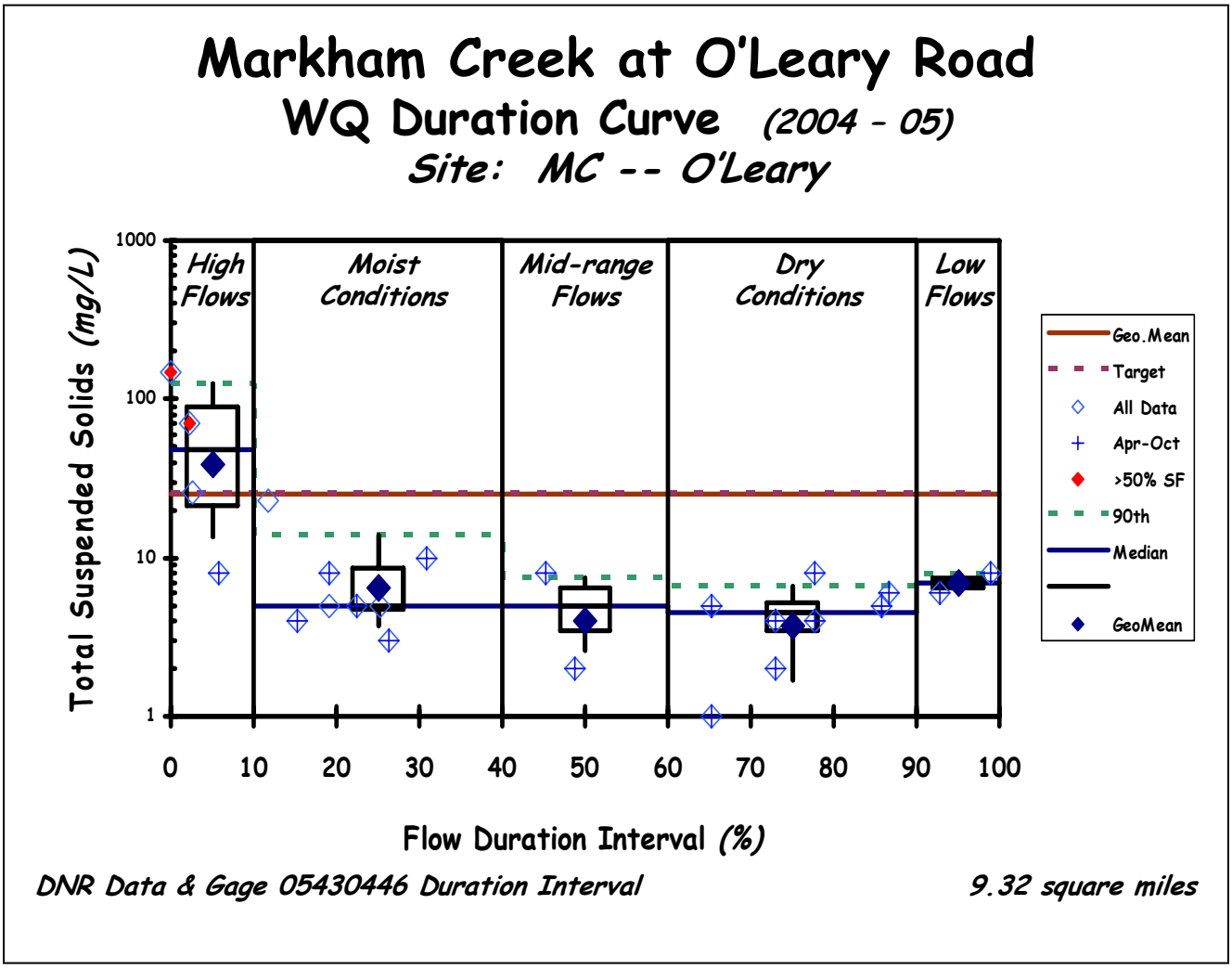
Figure 3. Markham Creek Watershed Land Use and Sampling Locations for TMDL Development

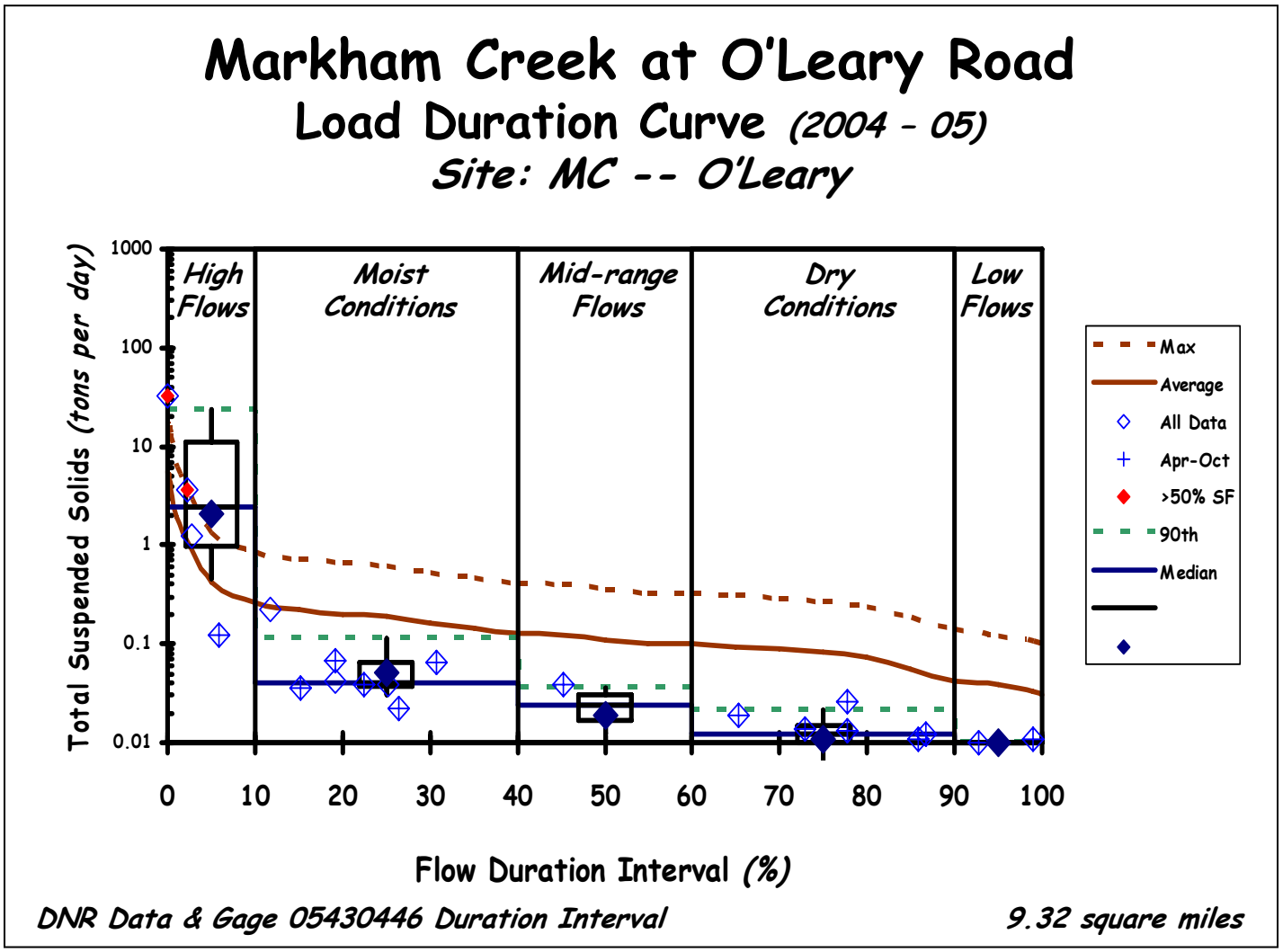
APPENDIX B: FLOW & LOAD DURATION CURVES

Flow duration curves display the cumulative frequency of the distribution of the daily flow for the period of record. Flow duration curves are transformed into load duration curves by multiplying the flow values along the curve by the TSS values and appropriate conversion factors. The x-axis represents the flow recurrence interval and the y-axis represents the allowable load of the water quality parameter. The TSS data points that are above the target line exceed the TSS target level; those that fall below the target line meet the TSS target.
The loading capacity was captured for these TMDLs using water quality duration curves. The full range of flow conditions can be seen in a duration curve. A flow duration interval is described as an interval (zero percent corresponds to the highest stream discharge or flood conditions, and 100 percent corresponds to the lowest discharge).




Stevens Creek at Hanover Road
Load Duration Curve (2004 - 05)
Site: SC -- Hanover
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
Total Suspended Solids (tons per day)
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Max
Average
All Data
Apr-Oct
>50% SF
90th
Median
DNR Data & Gage 05430540 Duration Interval
13.9 square miles


Markham Creek at O'Leary Road
WQ Duration Curve (2004 - 05)
Site: MC -- O'Leary
Total Suspended Solids (mg/L)
1000
100
10
1
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Geo.Mean
Target
All Data
Apr-Oct
>50% SF
90th
Median
GeoMean
DNR Data & Gage 05430446 Duration Interval
9.32 square miles


Markham Creek at O'Leary Road
Load Duration Curve (2004 - 05)
Site: MC -- O'Leary
Total Suspended Solids (tons per day)
1000
100
10
1
0.1
0.01
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Max
Average
All Data
Apr-Oct
>50% SF
90th
Median
DNR Data & Gage 05430446 Duration Interval
9.32 square miles